DOCUMENT RESUME

ED 418 578 EF 005 036

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TITLE Does It Matter Where Our Children Learn?
SPONS AGENCY National Academy of Sciences - National Research Council, Washington, DC.; National Academy of Engineering, Washington, DC.
PUB DATE 1998-02-18
NOTE 36p.; White Paper presented at an Invitational Meeting (Washington, DC, February 18, 1998).
PUB TYPE Opinion Papers (120) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Academic Achievement; Aesthetics; Educational Change; *Educational Environment; *Educational Facilities Design; Elementary Secondary Education; School Safety; School Security; School Size; School Space; *Teacher Student Relationship

ABSTRACT

This paper reports on research that suggests that how schools are designed can affect such important factors as student safety, teacher-student relationships, and the academic performance of students. School condition has some effect on test scores but also entails a moral obligation for students' safety; more research is needed to compare building conditions with achievement. The size of schools is a complex variable, and although some studies have offered ideal school populations, others have shown that both small and large schools have distinct benefits. Contemporary attitudes toward functional adequacy encompass school design, classroom design, and nonclassroom space (such as auditoriums), but these new trends are largely unsubstantiated with studies. Recent examination of air quality, temperature, lighting, and noise has shown that all affect achievement, but combined studies in these areas are lacking. Organization, architecture, and "pride of place" can prevent negative social interactions, but no studies seem to address the question of being "too secure." Modern literature proposes several benefits of school location, but fails to compare these benefits against one another. The effect of an environment's aesthetics is difficult to research because it affects each student differently; however, that often seems to be the most "real" variable. This white paper discusses such issues, examines the research and information available, and proposes a "systematic inquiry" across several fields in order to further substantiate proposed solutions to current educational demands. Contains 47 references. (RJM)

# DOES IT MATTER WHERE OUR CHILDREN LEARN?

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University of Virginia
1998



This White Paper was commissioned by the National Research Council of the National Academy of Sciences and the National Academy of Engineering for an invitational meeting on February 18, 1998, in Washington, D. C.

# DOES IT MATTER WHERE OUR CHILDREN LEARN?[1]

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American public education has always faced its share of challenges. Today these challenges include demands for higher standards and greater accountability, improved school security and student safety, new technology, stronger relationships between teachers and students, and greater parental and community involvement in schools. At the same time, school systems across the nation are confronting the need to build new schools and renovate aging facilities. President Clinton has identified school construction as a national priority, and states from Florida to New York to California have allocated billions of tax dollars to the cause.

Is there any reason to believe that the demand for new and renovated schools should be addressed apart from the other issues? I am an educator and an educational researcher, not an environmental psychologist, human factors researcher, architect or engineer; yet I cannot imagine that the quality of school facilities is completely unrelated to the challenges listed in first paragraph. In this White Paper I shall draw on various bodies of research in order to identify some of the connections between the settings in which students learn and the quality of public education.

Constructing a convincing argument that something makes a qualitative difference, of course, is a substantial challenge in and of itself. When a new medicine to relieve pain is developed, determining its effects is relatively simple. The impact often is immediate, dramatic,

[1] The author would like to acknowledge the valuable contributions to this paper by the following research assistants of the Thomas Jefferson Center for Educational Design: Dan Butin, Jacqui Griesdorn, and Dorothy Hart.

and easily measured. But what about a new school facility? The influence of settings frequently is subtle, sustained, and quite difficult to measure with precision.

Adding to the challenge of studying the effects of settings is the impact of personal experience. Virtually everyone probably can think of at least one occasion when they learned *despite* the setting. Memoirs and autobiographies are full of accounts of students who were undaunted by peeling paint, temperature extremes, poor lighting, cramped quarters, and other pathologies of place. I cannot deny that people are capable of learning in spite of the setting. The issue, however, is whether they learned as much or as well as they could have in better surroundings.

We live in an era of rising standards and expectations for student performance. In a book that influenced policy makers in the Clinton administration, Marshall and Tucker (1992) argued persuasively that American education would fail if it simply succeeded in helping disadvantaged students meet existing standards. What was needed in order for the United States to be competitive in a global market, they maintained, were higher educational standards for all students, even the very brightest.

To meet the challenge of higher standards and higher expectations, students are likely to need as many of the elements of a good educational experience as possible. The key, in other words, is not only good teachers or up-to-date instructional materials, but a complex array of direct and indirect influences on learning. It is the position of this White Paper that the quality of the settings in which students learn is one of these influences.

This paper reports on research that suggests that how schools are designed can affect such important factors as student safety, teacher-student relationships, and the academic performance of students. Much more research is needed, however, if we are to understand the precise nature

of these influences. It is one thing to state, for example, that small schools are safer than large ones, and quite another to provide evidence that a particular design for small schools is preferable to other designs.

While this paper focuses on research, including what is known and what needs to be known regarding school facilities, it is important to point out that research is not required to justify high quality schools. Where we choose to send our children for educational purposes ultimately is a matter of ethics and morality. Kozol (1991), in his disturbing analysis of affluent and impoverished school districts, and Jeffrey Hayden, in his film on disparities in the quality of school facilities in Ohio entitled "Children in America's Schools," offer eloquent testimony on the dreadful conditions in which many of our young people are required to learn. Even if no links between learning and facilities could be demonstrated scientifically, our society still would have a moral obligation to assign young people to safe and well-designed schools.

Organization of the Paper

One of the difficulties in reviewing research on the settings in which students learn is deciding on the boundaries of the phenomenon in question. Are we only concerned about school buildings? What about the grounds surrounding schools? Should the focus be limited to the physical structure of a school, or is it important to include other aspects of environmental design? These issues are discussed in the next section of the paper, and a case is made for defining the "territory" to be covered as "learning environments."

Related to the concept of learning environment is the proper designation for that which the learning environment is presumed to influence. Most observers would agree that learning is the primary purpose of schools, but what constitutes learning outcomes? Should our concern be limited to test scores? It may be difficult to prove that test scores are directly influenced by the

settings in which students learn, but are there intermediate outcomes which are shaped by setting and which, in turn, influence not only test scores, but other indicators of student achievement as well? To address these matters, I shall recommend a somewhat broad notion of student outcomes.

The main portion of the White Paper is devoted to the question: To what extent does existing research help us define and recognize a well-designed learning environment? If a well-designed learning environment is one in which students are likely to achieve desired outcomes, what is currently known about how to identify and create such environments? What more do we need to know in order to strengthen the links between learning and the settings in which it takes place? The paper concludes with a call for more focused inquiry into the physical conditions associated with effective learning. While it may be premature to search for evidence of one best school design, it would be difficult to argue that all school designs are equal. Some designs are likely to support effective teaching and learning better than others.

Framing the Problem

What is the territory researchers traverse when they study the settings in which students learn. Researchers using a variety of theories and perspectives have looked at the issue of setting, but they have not always agreed on the nature or the boundaries of the phenomenon. When behavioral psychologists think of setting, for example, they tend to concentrate on external stimuli and sources of reinforcement that influence and shape learning. Cognitive psychologists look at activity structures, opportunities for experience, and pattern of interaction between learners and teachers (Schauble and Glaser, 1996). Environmental psychologists, at least those who engage in environmental assessment, understand setting to be what inhabitants perceive it to be (Garling and Evans, 1991; Zube and Moore, 1987). Sociologists prefer to focus on the social

dimensions of context, while anthropologists attend to cultural dimensions. In an effort to expand environmental psychology and blend it with systems theory, some researchers recently have adopted an ecosystemic perspective that considers the influences on learning of networks of institutional processes (Jones, 1995, pp. 3-6). When architects and economists study setting, they zero in on the physical space in which learning is expected to take place, noticing such things as the relationship of form and function and the cost per student served.

Each of these perspectives makes a contribution to our understanding of setting. We learn, for instance, that the contexts in which learning takes place can be characterized in terms of their physical, social, and cultural dimensions. The physical dimension encompasses the built environment, including the organization, allocation and function of space. The social dimension subsumes the networks of relationships and groups in which individual learners find themselves. The cultural dimension encompasses the normative structures, expectations, beliefs, and values that influence learners' choices of what, where, and how to learn.

By combining these three dimensions, it is possible to conceive of a learning environment in the broadest possible terms. For present purposes, then, *a learning environment represents the physical, social and cultural context in which learning occurs*. The fact that learning can and does occur virtually everywhere suggests, of course, that it would be difficult to imagine an environment that is not a learning environment.

Too wide an aperture, of course, results in loss of resolution. In order to narrow the focus of this paper, it is therefore necessary to introduce the notion of intentionality. Learning , indeed, may occur everywhere, but every setting is not necessarily designed primarily for the purpose of learning. Furthermore, many settings are not designed at all. They either are natural or they result from the unplanned actions of individuals. The present concern is with *learning*

*environments intentionally designed for the primary purpose of learning.* A school, classroom, museum, or training facility clearly fit these parameters. Learning also may result from a visit to a retail outlet or a courthouse, but it cannot be said that these settings were intentionally designed for the primary purpose of learning.

In order to facilitate the following discussion, environments which have been created for the primary purpose of learning will be referred to as *planned learning environments* or PLEs. While the social and cultural dimensions of PLEs are vitally important, it is their physical dimensions that constitute the chief concern of this White Paper. *What is known, and what needs to be learned, about the relationship between the physical dimension of PLEs and student outcomes*?

Although the paper's focus has been narrowed considerably, it would be a mistake to think that the study of the physical dimension of PLEs is without complexity. First, the range of possibilities for investigation related to the physical aspects of PLEs is extensive. When McGuffey (1982) reviewed the subject, he found studies that sought to link learning to such physical variables as building age, ventilation, visual factors, color of interior of facilities, amount of space, design of space, lighting, site size, building utilization, building maintenance, special instructional facilities, and school size. To this list might be added other physical variables such as site location, security features, access for individuals with disabilities, and aesthetic appeal.

A second reason why studying the physical dimension of PLEs can be complex concerns the different ways in which this dimension can be characterized. For example, physical features tend to have "actuality" or concreteness that can be captured in relatively precise measurements – height, square footage, temperature, decibel level, air quality, and the like. Environments,

however, are not only measured; they are experienced and perceived (Canter, 1991). When the physical environment is experienced, the focus shifts to action. How do people actually behave in a particular setting? Are certain behaviors more likely in some settings than others? Do changes in the physical environment result in changes in behavior?

Physical aspects of environments also are perceived. In other words, individuals associate various feelings with the settings in which they learn. Meaning and significance may be attributed to certain physical aspects, but not others. Some facilities are perceived to have special symbolic value. Perceptions of the same environment may change over time. The relationships between the actual, the experienced, and the perceived physical environment represent an important, but somewhat neglected focus of study.

Ultimately there is little point in investigating PLEs unless such inquiry contributes to an understanding of what constitutes a *good* planned learning environment. This paper is concerned primarily with the physical characteristics of a good planned learning environment. Goodness, however, is a function of prevailing goals and values. The criteria for judging whether or not particular physical characteristics are "good," for example, may vary depending on whether the central goal is cost reduction, sustainability, or improved student achievement. While efficiency and environmental sensitivity are worthy values and should never be ignored by those who plan and design learning environments, student outcomes must be the central concern. In this paper, the goodness of a PLE—including its physical dimension—will be judged in terms of its impact on student outcomes.

Once more the issue of complexity arises, however. What constitutes a "student outcome?" Since Americans have found agreement on this matter virtually impossible, I shall not pretend that there is only one view of student outcomes. In seeking relationships between

PLEs and student outcomes, it will be necessary, therefore, to consider a variety of possible outcomes. Among the current collection of desired outcomes are high scores on standardized achievement tests and good grades. Graduation rates, college admissions, and employment after high school also are regarded as important. Many educators and business leaders have begun to stress the value of knowledge application as well as knowledge acquisition. They argue for more performance assessments to determine whether students can apply what they learn.

Besides these "direct" learning outcomes, school systems often strive to achieve a variety of "indirect" outcomes that are associated with student learning. They include good student attendance and conduct, positive feelings about school, strong teacher-student relationships, and high levels of parent involvement. The physical features of a PLE may not always directly influence test scores and graduation rates, but they still can exert an impact on learning indirectly. For example, if an inviting school environment increases the likelihood students will want to attend school, few would dispute the likely benefits for learning. Studies consistently show that it is difficult to learn when students are not in school.

To summarize, it has been stipulated that a good PLE is one that contributes directly or indirectly to the achievement of desired learning outcomes. The specific nature of these outcomes, though, may vary across school systems and time periods. It follows that a bad PLE is one that prevents or interferes with the achievement of desired learning outcomes. In theory, at least, it also is possible for some PLEs neither to contribute to, nor detract from, the achievement of desired learning outcomes. These PLEs would be regarded as neutral.

The specific ways by which the physical features of a PLE may influence student learning are seemingly endless. To assist in reviewing the range of possibilities, seven clusters of "physical" variables have been identified. They derive from a selective review of research

findings from architecture, behavioral psychology, cognitive psychology, education, engineering, environmental psychology, ergonomics and human factors research, medicine, organization development, and social psychology. Each cluster represents a related collection of physical conditions for which some reason exists to expect a direct or indirect influence on student learning. The clusters include structural condition, size and capacity, functional adequacy, environmental quality, safety and security, site location, and symbolic value and aesthetics. Each of these clusters will be discussed in the following sections.

Structural Condition

The need to rebuild and expand America's educational infrastructure is not in dispute. Legislatures and local education authorities across the country are taking the initiative to address deteriorating schools and demands for new facilities in high-growth areas. In Florida, for example, a special legislative session recently approved the expenditure of 2.7 billion dollars over the next five years for school construction. A poll of U. S. school board members in 1997 found that the need for school facilities was their second greatest concern, just behind school finance (*American School Board Journal*, December 1997, p.A15). School construction has even attracted the attention of the federal government. Alarmed by a 1996 report by the General Accounting Office (GAO), President Clinton has committed to providing federal funds to assist localities, particularly urban areas, in improving the conditions of their schools.

The GAO report estimated that three out of every five schools in the U.S. required extensive repair or replacement of at least one major feature, such as a roof or boiler. Almost 14 million students were compelled to attend school in buildings regarded as below standard or even dangerous. At the same time as existing facilities have been deteriorating, the school-age population has been growing dramatically in many areas. The number of children attending U.S.

schools will hit a record 52.2 million this year, and the trend is projected to continue through 2007, when enrollment in public and private schools should exceed 54 million (*Washington Post*, August 22, 1997, p. A-3). Bob Chase (1997), President of the National Education Association, refers to the intersection of growing school enrollment and aging school buildings as "the school infrastructure problem."

Research-based justification for school construction is hardly necessary when the safety and welfare of young people are at stake. The obligation to respond quickly is moral as well as practical. As the nation embarks on a school construction campaign that may rival that of the fifties, the question is this – *Is there any reason to believe that building new schools to replace aging facilities or undertaking extensive renovations in existing schools will increase the achievement of desired student outcomes*?

While this question has not received extensive attention by researchers, the studies that have been conducted suggest there may be a relationship between the condition of facilities and learning. McGuffey (1982) identified seven studies on the topic. Most utilized stepwise multiple regression to examine the possible relationship between student performance on standardized tests and the age of a school or a judgment of a school's condition. In almost every case, the newer or more "modernized" the school, the higher student test scores were likely to be. In one study of fourth-grade students in a random sample of elementary schools, for example, non-modernized buildings accounted for 5.3 percent of the variance on the composite score of the ITBS, *after controlling for socioeconomic status*. While this amount of variance may seem small when compared with the variance explained by the socioeconomic status of students' parents, it exceeds that of many educational variables.

Interestingly, when the quality of school facilities has been treated as one of several indicators of level of financial support for education, the relationship between facilities and student achievements sometimes disappears (Stockard and Mayberry, 1992, pp. 37-39). Several studies, however, indicate that the quality of facilities may be related to other desired outcomes, such as student attitudes toward school, self-esteem, security and comfort, and prosocial behavior (Weinstein, 1987; Weinstein, 1979).

Relatively little research on the condition of school facilities and the achievement of desired student outcomes has been undertaken since McGuffey's review in 1982. In one of the few recent studies, Berner (1993) hypothesized that parental involvement, as measured by a school's Parent-Teacher Association membership budget, is related to the condition of school buildings, which in turn, is related to student achievement. Focusing on the public schools of Washington, D. C., the researcher collected judgments of the condition of the schools from a local watchdog group. Schools were rated as poor, fair, or excellent, based on experts' opinions regarding needs for repairs and the adequacy of facilities for assigned programs. Building age also was considered. Student achievement was measured by the average CTBS score for each school. The study found that parental involvement was positively related to school condition, which in turn was positively related to student test scores.

The need clearly exists for more research on the possible links between the physical condition of PLEs and the achievement of desired student outcomes. Does building condition affect certain intervening variables which, in turn, influence student learning? "Time on task" may be one such variable. How much instructional time is lost or compromised as a result of

building-related problems.[2] Are students more likely to be absent when they are compelled to attend schools in poor condition? Are parents less likely to move into neighborhoods where schools are perceived to be outdated or deteriorating?

And what of those school systems growing faster than adequate facilities can be constructed? Does a school district like Broward County, Florida, pay a price in terms of student outcomes when it must use thousands of portable classrooms along with non-instructional space (such as cafeterias and auditoriums) to accommodate the 10,000 new students that arrive each year? In what ways does over-crowding take a toll on the physical plant, a toll that eventually may undermine student learning?

Size and Capacity

The preceding paragraph introduced the issues of school size and capacity, aspects of PLEs that are attracting considerable attention in rapidly growing parts of the United States as well as localities where budget problems have compelled educators to increase school and class sizes.

The issue of size turns out to be multi-dimensional and complex. Size, for instance, can refer to square footage as well as number of students. The focus of attention may be school size or classroom size. Actual size, in terms of either square footage or enrollment, may differ from perceived size.

Most research related to size has concentrated on student enrollment rather than square footage. Interestingly, school enrollment and class enrollment, while obviously dependent to some extent on the physical capacity of the space (square footage), are not closely related to each

[2] In Charlottesville, Virginia, for example, eight days of school were lost in the fall of 1997 when a boiler leaked over a weekend, flooding the high school.

other (Jones, 1995, p.83). Schools with relatively large numbers of students often are better able to offer small classes than small schools, which, because of staffing limitations, may be compelled to operate large classes.

A recent investigation of school size and student achievement found a curvilinear relationship between the two (Lee and Smith, 1997). The researchers examined student performance in reading and mathematics using data from the National Educational Longitudinal Study of 1988. They found that student achievement over the high school years was related to school size, with the ideal high school ranging form 600 to 900 students. Students tended to learn less in smaller schools and considerably less in larger schools. The adverse effects of size were particularly great for poor and minority students. The greatest negative effects of school size were found in high schools enrolling more than 2,100 students.

The discovery of an optimal size for high schools does not explain *how* size affects student learning. The need exists for research in the tradition of Barker and Gump's classic *Big School, Small School* (1964), which compared the experiences of being a student in a sample of large and small high schools in the Midwest. Do extremely small schools lack sufficient opportunities for student participation in enriching activities and specialty classes? Do extremely large high schools foster feelings of anonymity and lead to greater instances of disruption? One of the largest studies ever conducted of American adolescents recently found that the strongest school-based correlate of healthy adolescent behavior was close relationships with teachers (Resnick, et.al., 1997). Does the formation of such relationships become more difficult in very large high schools?

In a recent review of 103 studies of the relationship of school size to various aspects of schooling, Cotton (1996) found that in small schools

Academic achievement was at least comparable to—and often better than—that of large schools.

- Student views of school life in general and toward particular subjects were more positive.
- Student behavior—including truancy, discipline problems, violence, theft, substance abuse, and gang participation—was more positive.
- Levels of extra-curricular participation were higher, and students described their involvement as more fulfilling.
- Attendance was better and drop-out rates were lower.
- Relationships among students, teachers, and administrators were more positive.
- Students performed as well as those from large schools in such areas as college board scores, grade point averages, and college completion rates.

Large high schools originally were justified in terms of economies of scale and expanded opportunities for advanced course offerings. In fact, small high schools were regarded as a primary reason why the U.S. was not more competitive with the Soviet Union in the space race (Conant, 1959). Later, large high schools were seen as a key to desegregation. By bringing together students from various neighborhoods, large high schools would serve to accomplish what fair housing laws had failed to achieve. The Soviet Union no longer exists, and urban schools are more racially isolated than they were in the sixties. Even the presumption that larger schools are cheaper in the long run has been questioned (Frankl, 1992, p. 18). As thinking about the merits of smaller schools changes, it will be important for researchers to monitor the impact of downsizing projects, such as those now occurring in New York City high schools, on advanced studies, equity, and operating expenses.

The size of elementary schools has received less attention than the size of secondary schools, in part because it is generally assumed that small elementary schools are preferable to large ones. A survey funded by the Annie E. Casey Foundation (1997), in fact, acknowledged that one of the five "proven" correlates of success for elementary schools is relatively low enrollment. The State of Hawaii recently approved a policy to limit the maximum size of

elementary schools to 660 students (*Education Week*, April 2, 1997, p.4). Perhaps such action is a bit premature, however. When a study was done comparing the size of South Carolina elementary schools and their success in a statewide recognition program, the "smaller is better" assumption was not supported (Stevenson, 1997). The seven elementary schools that won the State Incentive Award all ten years of the program had an average enrollment of 818 students, more than 300 students greater than the average elementary school enrollment for the state.

Even the average size of a South Carolina elementary school would be considered too large in many countries. In Great Britain, for example, the proper size for an infant or junior school is considered to be approximately 300 students. School size, in fact, is felt to be far more important in Great Britain than class size, which often exceeds 35 students. In the U.S., on the other hand, class size frequently is perceived to be the more critical variable. While state and local policies rarely limit school size, as Hawaii has done, they often specify the maximum number of students per class. Obviously such policies create constraints within which school designers must work.

Recent research has found that class size is related to student achievement (Achilles, Finn, and Bain, 1997-98). Classes of about 15 students appear to benefit all elementary students (grades K through 3), particularly those in need of extra help. While hundreds of studies of *actual* class size have been conducted over the years, research on *perceptions* of class size is rare. Such research would take into account not only the number of students in a class, but the dimensions and arrangement of the space. It is conceivable, for example, that the negative effects of larger enrollments might be mitigated somewhat by more square footage. Cramming twenty students into 700 square feet may be more objectionable than accommodating the same

number comfortably in a room twice the size, where small groups can work without interfering with each other and students are not tempted by proximity to disturb their neighbors.

As with the issue of school size, it is necessary to increase our understanding of how size influences learning. Is actual enrollment more important than density (the relationship between enrollment and square footage)? Can classroom space be designed to accommodate larger numbers of students without adversely affecting learning? And what of alternative schools for students who have not experienced success in conventional PLEs? These settings may offer the best contemporary opportunities to study the combined effects of small school size *and* small class size. In any event, the full impact of size and capacity is unlikely to be understood until the perceptions and characteristics of individual students have been taken into account.

Functional Adequacy

The settings in which students are taught may be uncrowded and in good condition, but are they adequate for the functions that need to be undertaken? Functional adequacy concerns the appropriateness of the physical space allocated in PLEs for teaching and learning. It is dependent on square footage, but also on how the square footage is configured and organized with relation to other areas. When McGuffey (1982, pp. 267-270) reviewed research on school facilities in 1982, he found few studies of functional adequacy. What are some of the issues related to functional adequacy that merit investigation?

One set of issues concerns the overall design of a school and the extent to which the configuration of separate learning spaces contributes to its mission and supports its organizational philosophy. One elementary school, for example, may be organized around departmentalized classes for the intermediate grades, while another elementary school may embrace the notion of family-style organization, where students of varying ages remain within

the same cluster of classrooms for the duration of their primary and intermediate instruction. At the secondary level, some schools adopt team-based or interdisciplinary approaches in order to facilitate more integrated learning experiences. Schools designed to segregate different disciplines by department might be ill-suited to this purpose. As more PLEs are designed to advance particular missions, post-occupancy evaluations, environmental assessments, and comparative case studies will be needed to determine whether particular designs are more effective than others.

A second set of issues concerns the purposes and designs of individual classrooms. The curriculum, intended learning outcomes, teaching methods, and resources of the reading teacher are not identical to those of the algebra teacher or the Spanish teacher. Yet each is compelled in many schools to work in the same type of space. Years ago only teachers of music, physical education, vocational education, home economics, and laboratory sciences were likely to be assigned to specially designed classrooms at the secondary level. As foreign language and mathematics teachers shift their instructional focus to "laboratory" activities and teachers of other subjects differentiate their approaches to accommodate new instructional methods and technology, the traditional one-size-fits-all classroom is becoming obsolete. Desks for individual students are being replaced by work stations and furniture appropriate for cooperative learning groups. Space is needed to build, test, and store projects that have replaced paper-and-pencil tests I the wake of performance-based assessment. Classrooms are being redesigned to accommodate the needs of mainstreamed students with disabilities (Sydoriak, 1993). Taking into account new thinking about how students learn, Halsted (1992, p. 47) envisioned the classroom of tomorrow thusly:

- Classrooms will be like studios.
- Each student will have his or her own work station and research space.
- In addition, there will need to be an array of spaces of various sizes, including:
  -central gathering places, presentation arenas for the school community;
  -work spaces for cooperative learning by groups of different sizes;
  -quiet, private areas for one-to-one sessions with a teacher, mentor, or fellow student;
  -nooks where students can think and work independently;
  -offices for teachers where than can do individual testing and counseling, organize individualized study programs, phone parents, etc.

While teachers and students acknowledge the need for differentiated learning space, research to guide the customization of classrooms is scarce. Answers are needed to a variety of questions. For example—Are there better and worse ways to design classrooms to accommodate computers and other forms of technology? What designs are best suited to project or problem-based learning? Should classrooms have annexes where individual students can work while group instruction is taking place? Moore (1986) has paved the way to answering questions related to functional adequacy by developing and studying the concept of "architecturally well-defined behavior settings." Such settings contribute to longer student attention spans and decreased interruptions by providing clear boundaries and at least partial acoustic and visual separation.

A third set of issues relates to non-classroom space, including special areas like auditoriums and media centers. Educators and architects are rethinking designs for these areas in light of changing needs and technology. The advent of computer access to print media, for example, reduces the need for large libraries and increases the importance of immediate computer access in classrooms or satellite computer labs. The move to create full-service schools for at-risk students is necessitating the redesign of PLEs to accommodate offices for social services workers, clinics, and community centers. Community-minded educators want to

open school-based libraries and computer labs to adults. Day-care centers, parent education facilities, and special reception areas are being added to schools in an effort to encourage parental involvement and volunteerism. Some schools are even experimenting with creating museum-like exhibit areas and miniature neighborhoods with scaled-down versions of post offices, banks, and stores in order to stimulate student engagement in learning. Unfortunately, the implementation of these innovative designs is rarely accompanied by the systematic collection of data to permit subsequent assessment of their impact on teaching and learning.

Cutting across the various "domains" of functional adequacy are the issues of equity and expense. To what extent should educators be allowed to "customize" their PLEs? Prototypes and standardized learning spaces not only are cheaper in many cases, but they limit between-school and inter-department disparities in the quality of facilities. Is the value added to teaching and learning as a result of customization of schools and classrooms sufficiently great to offset concerns for higher costs and minimize objections to inequities across sites? Some architects contend that it is possible to obtain the benefits of prototypes, including reduced costs and quicker completion times, without sacrificing customization (Ehrenkrantz and Eckstut,1994). Ultimately, the central issue concerns the importance of variation. Research is needed to determine how much variation in the design and organization of PLEs is necessary to produce a demonstrable difference in the achievement of desired student outcomes.

Environmental Quality

Environmental quality refers to the sensory and health-related conditions that exist within PLEs. Of these conditions, the ones that have been studied most extensively relate to air quality, thermal factors, lighting, and noise level. Each has been found to affect the quality of teaching and learning. When the General Accounting Office (1996, pp. 39-42) surveyed the states

regarding school conditions, it found that substantial percentages of schools in most states were reported to have inadequate HVAC systems and lighting.

Perhaps no area of environmental quality has received greater attention recently than the quality of the air that students breathe in school. The problems range from respiratory infections and allergies to drowsiness and shorter attention spans (Ornstein, 1994, pp. 121-122). The causes include energy conservation efforts that result in tightly-sealed buildings, use of allergy-promoting floor coverings, and toxic emissions from cleaning fluids, paint, and other frequently used substances. If students do not feel good when they are in school or if they miss school due to air quality problems, learning is likely to be affected adversely.

Thermal factors can exert a similar impact on learning. When McGuffey (1982, p. 242-248) reviewed the literature, he found nine studies, eight of which indicated a significant relationship between thermal factors and student achievement and behavior. The primary thermal problem, perhaps surprisingly, is cooling, not heating. When McGuffey's work was discussed by two authorities, they noted, "Solar heat through glass, varying occupancy loads, and a fluctuating outside temperature often create overheated classrooms" (McGuffey, 1982, p. 285). Increased school construction in the Sun Belt along with the expansion of Year Round schools has led to greater interest in air conditioning for PLEs.

Lighting also has been found to affect student performance. Of the 10 studies reviewed by McGuffey (1982, pp. 248-253), all found a relationship between visibility and visual performance. Today there is little dispute regarding the value of lighting, but the issue concerns the best source of lighting. A growing group of environmentally active architects is promoting daylit schools (Thayer, 1995). Trying to reverse the trend toward fewer windows that characterized energy conscious school design in the wake of the OPEC crisis, these individuals

draw support from a Canadian study that compared the benefits of full-spectrum lighting (from natural light) and conventional electric lighting (McClintock, 1996, pp. 12-13). The study found that exposure to full-spectrum lighting was associated with better school attendance, greater concentration, more positive moods, and better scholastic performance.

The fourth dimension of environmental quality concerns noise level. In McGuffey's review (1982, pp. 256-259), seven studies were identified, and each reported a significant impact of hearing factors on student achievement. One study concerned the positive effect of desirable sound on performance, while the other studies focused on the negative impact of unwanted sound. Since the advent of open space design schools and workplaces, interest has grown in the issue of acoustical privacy (Wineman, 1982, pp. 265-267). The ability to regulate the oral transmission of information within groups or between student and teacher is a function, in part, of the design of learning space. Open space design schools failed, in part, because students and teachers lacked the privacy they felt was necessary to communicate effectively and complete assignments.

Research on environmental quality has tended to isolate variables such as air quality, temperature, lighting, and noise. What is missing from the literature are comprehensive studies of the collective impact of good air quality, appropriate temperature, and proper lighting and sound control. Such studies, of course, pose a challenge for researchers, since individual students are likely to be affected differently by each of these variables.

Safety and Security

Learning is less likely in settings where students and teachers do not feel safe. Unfortunately, many schools in the United States have become places where disruption, criminal

activity, and violence are all too common. To what extent do the physical surroundings in which teaching and learning to occur contribute to—or detract from—feelings of safety and security?

For many years researchers have known that school size is related to safety and security (Duke, 1990; Duke and Perry, 1978; Stockard and Mayberry, 1992). Smaller schools tend to have fewer behavior problems. This finding even pertains to alternative schools attended by students with histories of disruptive and undisciplined conduct (Duke and Perry, 1978). The benefits of smallness are not hard to identify. Where there are fewer students, it is easier for teachers to get to know each one and build constructive teacher-student relationships. In addition, school employees can more easily recognize strangers on campus and supervise students when they are not in class. In an effort to create a sense of "smallness," many large secondary schools have been sub-divided into "houses," each with its own student body, faculty, and administrator.

Large schools often are characterized by crowding, a condition that can encourage negative social interactions. Crowding occurs, in part, because of physical constraints—corridors that are too narrow to accommodate student traffic between classes, classrooms that lack sufficient space for students to work by themselves, and the like. When students are seated comfortably apart from each other, the temptation to touch and otherwise annoy each other is reduced. Research also indicates that crowding contributes to heightened anxiety and stress (Wineman, 1982, pp. 268-269).

Specialists in crime prevention suggest that those who design PLEs can help reduce the likelihood of inappropriate behavior by providing good lighting and clear sight-lines along hallways, in locker rooms, and other areas where adult supervision may not be continuous. Additional design features related to security include access control, graffiti-resistant surfaces,

and elimination of nooks and crannies that are difficult to monitor (Crowe, 1991). Some schools are trying to reduce misconduct by replacing large restrooms with private bathrooms (Genervro, 1990). When a team of M.I.T. designers (Strickland, 1994, pp. 49-50) created guidelines for the new American School Design Project, they found that school safety could be promoted when

> ...administrative offices overlook courtyards and school entrances, teachers' offices are distributed throughout the buildings and have glass walls looking into stairhalls and corridors, and corridor windows encourage the informal monitoring of indoor and outdoor spaces.

In thinking about the links between physical surroundings and safety, it is also important not to underestimate the impact of "pride of place." Attractive facilities characterized by features with which students readily can identify are more likely to inspire good conduct and reduce vandalism than ordinary, uninspiring, and poorly maintained facilities (Crowe, 1991).

Several years ago the school system in Dallas, Texas, opened a new, 41 million dollar high school. Spending for security for Townview Magnet Center was put at 3.5 million dollars (Portner, 1995). The school boasted 37 surveillance cameras, six metal detectors, intruder-resistant gates, catwalks above the cafeteria, and perimeter lighting around the entire 20 acre campus. The construction of schools such as Townview raises a question which researchers need to address. Is it possible for a school to be too "secure" in its design? At what point does concern for safety result in design decisions that actually promote misconduct and challenges to authority? -

Site Location

In an effort to locate links between learning and the physical dimension of PLEs, it would be a mistake to overlook the possible impact of location. Where a PLE is placed can affect a number of things, from the time it takes to travel to and from the facility to the learning resources

available once students arrive. Site location also determines, to some extent, the diversity of the student body, access to parents, and patterns of community development.

In her recent analysis of how to strengthen families and neighborhoods in the U.S., Schorr (1997, pp. 360-361) concludes that successful community-building initiatives combine action in the economic, service, education, and physical development domains. The key, in other words, is adopting what she calls a "comprehensive mind-set." Improving learning for poor inner-city students should not be regarded simply as a matter of raising standards or increasing high-stakes testing. The improvement of learning is linked closely to the improvement of the community in which students live. A state-of-the-art PLE has the potential, if located properly, to stimulate the revitalization of a declining neighborhood. Sending young people to schools outside their neighborhoods once seemed a necessary element of desegregation plans, but community developers and politicians increasingly are realizing that such a strategy can have adverse consequences for neighborhood infrastructure, including local schools (Duke, 1995).

Where PLEs are located can play a central role in determining where people with children live. Parents generally prefer to live relatively close to the places where they send their children to learn. Close proximity reduces the time required for transportation to and from school—time that might be spent on more productive activities, increases the likelihood of parental involvement in school, and simplifies the task of retrieving children when they must leave school due to sickness or appointments.

Sometimes, of course, parents work a considerable distance from where they live. A relatively new development in public education is the satellite learning center (Murray, 1997). During the past decade, corporations in 30 localities have worked with school districts to create satellite learning centers for the children of employees. The centers are located adjacent to

corporate headquarters and in commercial areas. While systematic research on the benefits of locating PLEs close to where parents work has yet to be undertaken, a small-scale study of the Hewlett-Packard learning center in Santa Rosa, California, found that reading scores for students at the center were 43 percent higher than those of other public school students in the district (Murray, 1997).

Where PLEs are located can enhance access to learning resources as well as working parents. First, there is the nature of the site itself. The natural environment surrounding PLEs has great potential to serve as a locus for learning. Schools have engaged students in developing adjacent wetlands, nature trails, gardens, and other "learning landscapes." Accessibility is the key to the value of these projects. Teachers can plan meaningful learning activities on the spur of the moment, without worrying about transportation arrangements or field trip coordination.

Recognizing the potential learning value of milieu, some designers have urged the location of PLEs in stimuli-rich settings such as zoos and museums (Carrns, 1997). Current examples include the Zoo School, located on the grounds of the 500-acre Minnesota Zoo in Minneapolis, and the Henry Ford Academy of Manufacturing Arts & Sciences, located at the Henry Ford Museum in Dearborn, Michigan. Placing PLEs in such settings is consistent with prevailing thinking about cognitive development that stresses the value of active engagement in learning, rich and varied experiences, and multiple intelligences.

Even though it may not always be possible to locate a PLE within a facility such as a zoo or museum, consideration can be given to placing it near enough to businesses, public buildings, and parks to permit easy access by students. Such placement may call for the renovation of existing facilities rather than new construction. Carefully located PLEs can expand learning

opportunities immensely, including work-study and community service placements, access to adult mentors, and observations of "government in action" at local courthouses and city halls.

Understanding the value of location requires an appreciation of trade-offs. What price is paid in lost learning opportunities when new schools are placed in sylvan settings where new residential development is anticipated? Is proximity to home of greater importance than proximity to urban resources? If large schools cannot be accommodated in business districts and novel sites, is it better to sacrifice size for location? Other than studies related to school desegregation, relatively little research currently is available on the costs and benefits to learning of PLE placement.

Symbolic Value and Aesthetics

The final aspect of PLEs to be discussed is, in some ways, the least easily researched, yet in other ways, the most "real." Buildings, settings, and environments are accorded symbolic value by those who use them as well as those who do not. In other words, physical entities like a school come to symbolize certain qualities, values, aspirations, and experiences for individuals. The same school may represent quite different things for different individuals. To a poor student from a tenement, a school may symbolize opportunity, hope, stability, and a safe haven in a world of insecurity and transience. To another student whose school experiences have been unpleasant, the physical structure he enters each day may symbolize failure and oppressive adult authority.

Aesthetics encompass the qualities which help to determine the symbolic value of the structures and forms which human beings experience. While scholars strive to identify aesthetic qualities that generalize across particular groups and cultures, individuals also experience the places they inhabit in highly personal and idiosyncratic ways. While it is not easy to document

the impact of aesthetics on human behavior, most people readily admit to feeling different when they enter a cathedral and a cafeteria.

The symbolic value and aesthetics of PLEs pose at least two major challenges for researchers. The first involves trying to understand the role played by the physical dimension in shaping how students in general feel about learning. The second concerns the qualities that each individual associates with the settings in which they learn best.

The first challenge relates to the collective experience of architecture and the built environment. As far back as the thirties researchers recognized what Murray (1938) termed "environmental press," the notion that environments are perceived by people as having different personalities. People who share certain values, cultural backgrounds, and life experiences often perceive environments similarly. It should surprise no one that inner city students compelled to attend unattractive and poorly maintained schools may feel diminished and less valued as a consequence (Carnegie Foundation for the Advancement of Teaching, 1988). Moore (1995, p. 4) puts it well when he says, "Our school facilities are a tangible symbol of our commitment to education, and the message is not lost on students." What is the message, we must ask, when a city spends enough on a new football stadium to rebuild every one of its public schools. What is the impact, direct or indirect, of such messages on the achievement of desired learning outcomes? Or what about the programs which school architecture helps to feature? One message is conveyed when everyone entering a high school must pass vocational-technical classrooms with glass walls permitting student activities to be viewed. Another message is sent when vocational-technical instruction is relegated to an annex or the rear of the school. That schools can be designed to symbolize adult authority and control has been demonstrated for

decades. Do we also possess the imagination and skills to design schools that represent a deep caring for young people and embody the nurturing qualities of home-like environments?

The second challenge pertains to the somewhat unique ways in which each individual values and makes sense of the physical settings in which they learn. A review of research on school environments and stress (Ahrentzen, Jue, Skorpanich, and Evans, 1982, p. 249) characterized the impact of the physical environment on individuals in the following way:

> The physical environment rarely has direct, unmediated impacts on human health and well-being. As we suggest, it is the *interaction* of individual characteristics with physical features of the environment that one must look at to more adequately understand how school environments affect behavior.

Just as no two students learn in exactly the same way, they do not perceive the settings in which they learn identically.

Based on this view, some theorists argue that less attention should be paid to questions of causation and more to matters of optimization. Jones (1995, p. 49) captures this position in the concept of *locational functioning*:

> ...locational functioning refers to the convergence of place features, and behaviours and perceptions of the people who interact with it. The implicit message is that instead of seeking to delineate causal relationships between spatial features and educational outcomes, the focus should be on identifying optimal environments for educational activities.

By coming to understand better how individual students perceive, value, and feel about the places where they are expected to learn, researchers can determine the extent to which a variety of PLEs may be required in order to optimize learning. Whether society will be willing to pay the cost of customizing PLEs, of course, is another matter entirely.

## Conclusion

Is enough known about the relationship between learning and where it occurs to answer the question that serves as this paper's title? Based on a review of various literatures, it is my judgment that sufficient indications of a relationship exist to merit further inquiry. Many unanswered questions may remain, but there is no reason at this point to argue that further exploration of the topic is a waste of time and energy. Quite the contrary, in fact. From the condition and size of PLEs to how they are arranged and utilized, physical dimensions of learning clearly matter. A better understanding of why they matter and how the design of PLEs can be improved to accommodate students with different learning needs should be high on the agenda of any nation embarking on a multi-billion dollar school construction program.

It has been suggested in this White Paper that the quest for *direct* links between learning and physical conditions may not always be as productive as research on how physical conditions *indirectly* influence student outcomes. Researchers already have shown that student outcomes are a function of such factors as the quality of instruction, instructional time, parental involvement, and how students feel about school. How do physical conditions such as school size, functional adequacy, and environmental quality affect these variables, which in turn impact learning?

We need to increase our awareness of the interactions between physical conditions and the characteristics of different learners, while, at the same time, addressing the learning needs of groups. It is probably impossible to create a customized PLE for every student. Given the practical constraint of cost, can research inform the efforts of architects, engineers, and educators to design the next generation of American schools? We have strong reason to believe, for example, that small schools are better than large schools for many students, but we do not yet

know the best designs for small schools. Research has tended to compare small schools and big schools, not small schools with other small schools. As a consequence, we are unsure whether one small school design is preferable to another.

It is one challenge to imagine new designs for learning environments, and quite another challenge to study competing designs to determine which are most likely to facilitate achievement of desired student outcomes. The past four decades have witnessed the development of a variety of new school designs, ranging from those that promote family grouping and teaming to designs for departmental and interdisciplinary learning. What is now needed is systematic inquiry to determine whether certain designs are more effective than others for particular purposes.

To address these and related issues will require the concerted and collaborative efforts of researchers representing a variety of fields—including architecture, education, learning theory, engineering, technology, and environmental psychology. A limitation of existing inquiry on PLEs has been the tendency for researchers to work in isolation on specific variables. More comprehensive investigation is needed if major advancements in the design of PLEs are to be made. The coming decade will witness a burst of school construction to rival the building boom of the fifties. The only question is whether or not those engaged in this activity will have at their disposal up-to-date research on the best designs for learning.

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